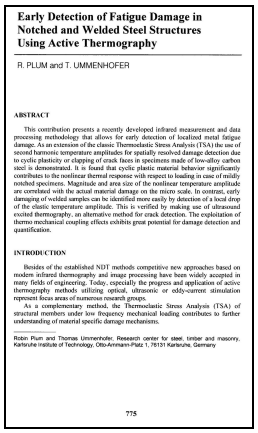
Early Detection of Fatigue Damage in Notched and Welded Steel Structures Using Active Thermography

R. PLUM and T. UMMENHOFER

ABSTRACT

This contribution presents a recently developed infrared measurement and data processing methodology that allows for early detection of localized metal fatigue damage. As an extension of the classic Thermoelastic Stress Analysis (TSA) the use of second harmonic temperature amplitudes for spatially resolved damage detection due to cyclic plasticity or clapping of crack faces in specimens made of low-alloy carbon steel is demonstrated. It is found that cyclic plastic material behavior significantly contributes to the nonlinear thermal response with respect to loading in case of mildly notched specimens. Magnitude and area size of the nonlinear temperature amplitude are correlated with the actual material damage on the micro scale. In contrast, early damaging of welded samples can be identified more easily by detection of a local drop of the elastic temperature amplitude. This is verified by making use of ultrasound excited thermography, an alternative method for crack detection. The exploitation of thermo mechanical coupling effects exhibits great potential for damage detection and quantification.

INTRODUCTION

Besides of the established NDT methods competitive new approaches based on modern infrared thermography and image processing have been widely accepted in many fields of engineering. Today, especially the progress and application of active thermography methods utilizing optical, ultrasonic or eddy-current stimulation represent focus areas of numerous research groups.

As a complementary method, the Thermoelastic Stress Analysis (TSA) of structural members under low frequency mechanical loading contributes to further understanding of material specific damage mechanisms.

Robin Plum and Thomas Ummenhofer, Research center for steel, timber and masonry, Karlsruhe Institute of Technology, Otto-Ammann-Platz 1, 76131 Karlsruhe, Germany

775

Код: 10334

R. Plum, T. Ummenhofer

Early Detection of Fatigue Damage in Notched and Welded Steel Structures Using Active Thermography

Издательство DEStech Publications, Lancaster, 2011 год

8 стр; формат: 23,5 x 16 см; библиографический список: 9 единиц
ISBN: 978-1-60595-053-2

This contribution presents a recently developed infrared measurement and data processing methodology that allows for early detection of localized metal fatigue damage. As an extension of the classic Thermoelastic Stress Analysis (TSA) the use of second harmonic temperature amplitudes for spatially resolved damage detection due to cyclic plasticity or clapping of crack faces in specimens made of low-alloy carbon steel is demonstrated. It is found that cyclic plastic material behavior significantly contributes to the nonlinear thermal response with respect to loading in case of mildly notched specimens. Magnitude and area size of the nonlinear temperature amplitude are correlated with the actual material damage on the micro scale. In contrast, early damaging of welded samples can be identified more easily by detection of a local drop of the elastic temperature amplitude. This is verified by making use of ultrasound excited thermography, an alternative method for crack detection. The exploitation of thermo mechanical coupling effects exhibits great potential for damage detection and quantification.

Ключевые слова:

Содержание.